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METHODS OF ARTIFICIAL PARTHENOGENESIS.

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Papers on the subject of artificial parthenogenesis have been fairly abundant during the past ten years, yet somewhat scattered, appearing in zoological, physiological and chemical journals. It therefore seemed desirable to list the important contributions, giving briefly, but in detail, the various methods of exciting eggs to develop, together with results and references, in the hope that it might prove of value to future workers.

Such a list follows. Only annelids, echinoderms, molluscs and vertebrates have been included. Under each class the observers are arranged in alphabetical order; their researches in chronological order.

As the most important general and theoretical work on artificial parthenogenesis may be mentioned the recent book of Loeb, "Die Chemische Entwicklungserregung des tierischen Eies," Berlin, 1909, in which the various phases of this most interesting subject are discussed in considerable detail.

The following abbreviations have been used :—

s. w. sea water.

m. molecular solution.

n. normal solution.

min. minute.

hr. hour.

dist. w. distilled water.

P. B. polar bodies.

esp. especially.

P. D. potential difference.

ANNELIDS.

Egg of	Preliminary Treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
<i>Ophelia</i> .	Hypertonic sea water (20 c.c. 2.5 m. KCl + 80 c.c. s.w. for 2 hrs. at 18°).	To s.w. Swimming larvæ.	60	Bullost, G.	<i>Arch. Entom.</i> , XVIII., p. 161, 1904 and <i>U. Calif. Pub. Physiol.</i> , I., p. 105, 1904.
<i>Amphitrite</i> .	Hypertonic sea water (98 c.c. s.w. + 2 c.c. 2.5 m. Ca (NO ₃) ₂ for 30 min.).	To s.w. Trochophores.		Fischer, M. H., at Woods Hole.	<i>Am. J. Physiol.</i> , 7, p. 301, 1902.
"	Calcium ions (98 c.c. s.w. + 2 c.c. m. Ca salt).	Permanently. Mg, Li and Na cause no development.		Fischer, M. H., at Woods Hole.	<i>Am. J. Physiol.</i> , 7, p. 301, 1902.
"	Mechanical agitation.			Fischer, M. H., at Woods Hole.	<i>Am. J. Physiol.</i> , 7, p. 301, 1902.
<i>Nereis</i> .	Hypertonic sea water by NaCl, KCl or cane sugar (17.5 c.c. 2.5 m. KCl + 82.5 c.c. s.w. for 1 hr.).	To s.w. Swimming larvæ.		Fischer, M. H., at Woods Hole.	<i>Id.</i> , 9, p. 100, 1903.
<i>Thalassemae mellita</i> .	Acids (mineral, fatty, dibasic organic and CO ₂). 17 c.c. m/10 HNO ₃ + 83 c.c. s.w. for 5 m. 15 c.c. m/10 HCl + 85 c.c. s.w. for 5 m. 10 c.c. m/20 H ₂ SO ₄ + 90 c.c. s.w. for 8 m. 12 c.c. m/20 (COOH) ₂ + 88 c.c. s.w. for 8 m. 15 c.c. m/10 CH ₃ COOH + 85 c.c. s.w. for 5 m. CO ₂ from generator to s.w. for 10 m. and eggs immersed 1 hr.	To s.w. Trochophores.	6 to 60	Lefevre, G., at Beaufort, N. C.	<i>Journ. Exp. Zool.</i> , IV., p. 90, 1907.
<i>Chaetopterus</i> .	KCl sea water (10-20 c.c. 2.5 n KCl + 90-80 s.w. for 1 hr.)	Confirms Loeb.		Lillie, F. R.	<i>Arch. Entom.</i> , XIV., p. 477, 1902.
<i>Chaetopterus</i> , <i>Phascolosoma</i> , <i>Podarke</i> .	Hypertonic sea water (15-20 c.c. 2.5 n NaCl + 85 c.c. s.w. for 1 hr.).	To s.w. "swimming larvæ."		Loeb, J., at Woods Hole.	<i>Am. J. Physiol.</i> , IV., p. 423, 1901, and <i>Science</i> XII., p. 170, 1900.
<i>Chaetopterus</i> .	Potassium ions (10 c.c. 2.5 n KCl + 90 c.c. dist. w. for 7 m.)			Loeb, J., at Woods Hole.	<i>Am. J. Physiol.</i> , IV., p. 423, 1901, and <i>Science</i> , XII., p. 170, 1900.

ANNELIDS.—Continued.

Egg of	Preliminary Treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
<i>Chetopterus</i> .	Acids (100 c.c. s.w.+1-2 c.c. HCl and left permanently).	Segmentations.	Small	Loeb, J., at Woods Hole.	<i>Amer. J. Physiol.</i> , IV., p. 423, 1901, and <i>Science</i> , XII., p. 170, 1900.
<i>Polynoë</i> , <i>Sipunculus</i> .	Alkalies (50 c.c. s.w.+1.5 c.c. $n/10$ NaOH) permanently or 5-6 hrs.	To s.w. Larvæ.	30 30	Loeb, J.	<i>Pfugers Archiv</i> , 118, p. 572, 1907, and <i>U. Calif. Pub. Phys.</i> , 3, p. 71, 1907.
<i>Polynoë</i> .	Alkali (dilute) for 4 hrs.	50 c.c. $5/8$ m. Vant' Hoff's sol.+10 c.c. 2.5 m. NaCl for 2 hrs.			<i>U. Calif. Pub. Phys.</i> , 3, p. 71, 1907.
"	Saponin and solanine (15 drops weak sol. in 4 c.c. s.w. for 1-1.5 min.)	To s.w. Larvæ.	Most	Loeb, J.	<i>Arch. f. d. ges. Physiol.</i> , 122, p. 448, 1908.
<i>Amphitrite</i> .	Hypertonic sea water, Ca ions and Mechanical Agitation.	Confirms Fischer.		Scott, J. W., at Woods Hole.	<i>J. Exp. Zool.</i> , 3, p. 62, 1906.
<i>Podarke</i> .	Hypertonic sea water (20 c.c. 2.5 KCl+80 c.c. s.w. for 1 hr.).	To s.w. swimming larvæ.		Treadwell, A. L., at Woods Hole.	<i>Biol. Bull.</i> , 3, p. 235, 1902.

HOLOTHURIANS.

<i>Holothuria tubulosa</i> .	Acids (3 c.c. $m/10$ HCl+100 c.c. s.w. for 5 min.).	To s.w. Segmentations but no larvæ.		Lyon, E.P. at Naples.	<i>Am. J. Physiol.</i> , IX., p. 308, 1903.
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MOLLUSCS.

Egg of	Preliminary Treatment	After Treatment and Remarks.	Per cent.	Observer.	Reference.
<i>Macra</i> .	Hypertonic sea water (5-15 c.c. 2.5 n KCl, NaCl, CaCl ₂ to 85-95 c.c. s.w. for .5-2 hrs.). Concentrated (by evap.) s.w.	To s.w. Segmentations.		Kostanecki, K., at Naples.	<i>Arch. f. micros. anal.</i> , 64, p. 1, 1904, also <i>id.</i> , 72, p. 327, 1908.
<i>Lolita gigantea</i> .	Hypertonic sea water (15-20 c.c. 2.5 m KCl to 100 c.c. s.w. for 2 hrs.).	To s.w. Swimming larvæ.		Loeb, J., at Pacific Grove.	<i>U. Calif. Pub. Phys.</i> , 1, 1903, p. 7.
<i>Acmaea</i> sp.	10 c.c. 2.5 m KCl to 100 s.w. 2 hrs.	To s.w. Swimming larvæ.		Loeb, J.	<i>Id.</i>

MOLLUSCS.—Continued.

Egg of	Preliminary Treatment.	After Treatment and Remarks.	Per Cent.	Observer.	Reference.
<i>Lottia gigantea</i> .	Hypertonic alkaline solution (50 c.c. 5/8 m Van't Hoff + 10 c.c. 2.5 n NaCl + 0.5 c.c. n/10 NaOH for 2 hrs.	For artificial maturation methods see To s.w. Swimming larvae.	Almost all.	Loeb, J. Wolfsohn, J. M. Loeb, J.	<i>Id.</i> , III., p. 1, 1905. Biol. Bull., 13, p. 344, 1907. <i>Arch. f. d. ges. Physiol.</i> , 118, p. 575, 1907.
STAR-FISH.					
<i>Asterias glacialis</i> .	Hypertonic sea water (by K, Na, Mg. .73 n.) for 1 hr.	To s.w. Blastulæ.		Delage, Y.	<i>Arch. d. Z. Exp. et Gen.</i> , 3d, 9, p. 307, 1901.
"	Heat (s.w. at 28°-35° allowed to cool by radiation or by cold).	Blastulæ.	25	"	<i>Id.</i> , p. 307.
"	Acid (HCl 0.1-0.2 g. per L.) to s.w.	"	50	"	<i>Id.</i> , p. 309.
"	Manganese sea water. s.w.-260 .506 m. } .506 m. MnCl ₂ -.246	Heat + KCl s.w. to s.w. Heat + HCl s.w. to s.w. To s.w. segmentations. MnCl ₂ s.w. + HCl to s.w.	40 100 5	"	<i>Id.</i> , p. 313.
"	.52 m. MnCl ₂	To s.w.	45	"	<i>Id.</i> , 4th, 3, Notes et Revue, p. clxvi; also C. R. Ac. Sc. Paris, 140, p. 1369, 1905.
"	CO ₂ Charged s.w. for 1 hr. (between breakdown of germinal vesicle and appearance of ♀ pronuc.).	To s.w. "Auriculariæ."	100	"	<i>Id.</i> , 3d, 10, p. 213, 1902, and C. R. Ac. Sc. Paris 135, p. 605, 15, 570. <i>Id.</i> , 137, p. 473.
"	Mechanical agitation.	Segmentation and a few blastulæ.	5-30	"	
"	Sodium phosphate sea water. ¹ NaH ₂ PO ₄ . .270 } s.w. .355 }	Numerous larvæ.	3	"	<i>Arch. d. Zool. Exp. et Gen.</i> , 4th, 3, Notes et Revue, p. clxviii, 1905.

¹ Efficiency probably due to presence of H ions.

STAR-FISH.—Continued.

Egg of	Preliminary treatment	After Treatment and Remarks.	Per cent.	Observer.	Reference.
<i>Asterias forbesii</i> .	Cold (s.w. at 4°-7° C. for 1-9 hrs., after maturation).	Bipinnaria larvæ.	20	Greeley, A. W.	<i>Am. Journ. Physiol.</i> , VI., p. 296, 1902.
<i>Asterias forbesii</i>	Heat (s.w. at 35°-70 min.; 36°-45 min.; 37°-30 min. 38°-20 min.; after dissolution of germinal vesicle and before separation of 1st. P.B.).	To s.w. Bipinnaria larvæ.	High.	Lillie, R. S.	<i>J. Exp. Zool.</i> , V., p. 375, 1908.
"	m/2000 KCW in s.w. for 50 min., then heat (as above).	To s.w. Bipinnaria larvæ.	100	"	<i>J. Exp. Zool.</i> , V., p. 375, 1908.
"	m/2000 KCN in s.w. for 50 min., then heat to m/2000 KCN in s.w. for 5-10 min.	To s.w. Bipinnaria larvæ.	100	"	<i>J. Exp. Zool.</i> , V., p. 375, 1908.
<i>Asterina</i> .	Acids (5 c.c. n/10 fatty acid + 50 c.c. s.w. for 1-2 m.).	To s.w. Blastulæ.	10	Loeb, J.	<i>U. Calif. Pub. Physiol.</i> , II., p. 147, 1905.
"	Fat solvents (amylen, benzol, sat. sols. in s.w.).	Membranes formed.		"	<i>Id.</i> , p. 149.
<i>Asterias</i> .	Acids (3-5 c.c. n/10 inorganic acid esp. HCl to 100 c.c. s.w. for 3-20 min.).	To s.w. swimming larvæ.	20	Loeb, J., Fischer, M. and Neilson, H.	<i>Arch. f. d. ges. Physiol.</i> , 87, p. 1, 1901.
"		For substances causing maturation see		Loeb, J.,	<i>Biol. Bull.</i> , III., p. 295, 1902.
<i>Asterias forbesii</i> .	Mechanical agitation (after maturation; 3 hrs. after shedding optimum time).	Bipinnaria larvæ and gastrulæ.	50	Matthews, A. P., at Woods Hole.	<i>Am. J. Physiol.</i> , VI., p. 142, 1902.
<i>Asterias</i> .	Distilled water (1 min.).	To s.w. Larvæ.		Schücking, A., at Naples.	<i>Arch. f. d. ges. Physiol.</i> , 97, p. 85, 1903.
"	Electric current (constant, from 2 chronic acid elements). 2 min.	Segmentation.		Schücking, A., at Naples.	<i>Id.</i>
"	Acids (acetic and citric) 2 drops conc. CH ₃ COOH to 200 c.c. s.w. for 40 min.).	To s.w. larvæ.		Schücking, A. at Naples.	<i>Id.</i>

STAR-FISH.—Continued.

Egg of	Preliminary treatment	After Treatment and Remarks.	Per cent.	Observer.	Reference.
<i>Asterias</i> .	NaHCO ₃ (1.5 per cent. for 1.25 hrs.). Heat (s.w. at 34° C.).	To s.w. Bipinnaria and blastulae.		Schücking, A., at Naples.	<i>Arch. f. d. ges. Physiol.</i> , 97, p. 85, 1903.
SEA-URCHINS.					
<i>Strongylocentrotus lividus</i> .	Hypertonic solutions (by KCl, NaCl, MgCl ₂). s.w. .317 ¹ } .817 n for 1.5 hrs. KCl .500 } Manganese sea water. s.w. .156 } .648 n. MnCl ₂ .492 }	To s.w. Segmentations and blastulae.	80 75	Delage, Y.	<i>Arch. d. zool. Exp. et General.</i> , 3d, 9, 1901, p. 296. <i>Id.</i> , p. 311.
<i>Strongylocentrotus lividus</i> .	CO ₂ sat. s.w. at 28°-30° C. (allowed to cool by radiation) for 1 hr.	To s.w. Segmentations.	15	"	<i>Id.</i> , 4th, 2, pp. 43-46, 1904.
<i>Strongylocentrotus lividus</i> .	Nickel and Cobalt sea water (100 c.c. hypertonic s.w. .95 n + 1-1.5 c.c. n NiCl ₂).	To s.w. Larvæ.	60	"	<i>C. R. Ac. Sc. Paris</i> , 143, p. 863, 1906.
<i>Strongylocentrotus lividus</i> .	Na hyposulphite sea water ² (100 c.c. hypertonic s.w. .95 n + 5-10 drops n Na hyposulphite). Acid and alkali [strong hypertonic sol. (41.5 c.c. 2.5 n NaCl + 2.5 c.c. s.w. + 50 c.c. dist. w.) + 17 drops n/10 HCl for 5-6 min.]	To s.w. CoCl ₂ less effective. More effective when Ni applied after hypertonic sol.		"	<i>C. R. Ac. Sc. Paris</i> , 143, p. 863, 1906.
<i>Strongylocentrotus lividus</i> .	HNO ₃ . H ₂ SO ₄ . (COOH) ₂ . CH ₃ COOH. HCOOH. NaOH; Ca(OH) ₂ . Na ₂ CO ₃ favorable but not KOH. Treatment cannot be reversed. Larvæ obtained.	Weak hypertonic sol. (37.5 c.c. 2.5 NaCl + 2.5 c.c. s.w. + 60 c.c. dist. W.) + 17 drops NH ₄ OH for 1 hr. 20 m.; to s.w.	High.	"	<i>Arch. d. zool. exp. et gen.</i> , 4th, 7, 1907, p. 445, also <i>C. R. Ac. Sc. Paris</i> , 145, p. 218, 1907.

¹ Gram molecules of the salt in a liter of water. 5/8 m. = .625 m. ² Efficiency probably due to increase of OH ions.

SEA-URCHINS.—Continued.

Egg of	Preliminary treatment	After Treatment and Remarks.	Per cent.	Observer.	Remarks.
<i>Strongylocentrotus lividus</i> .	Tannin and ammonia—50 c.c. sol. (hypo- ¹ iso- and hypertonic sols. of various salts, salt mixtures and sugar)+28 drops $n/10$ tannin ($C_{14}H_{10}O_9=322$) for 5-6 min. Orcinol, resorcinol, phloroglucine, pycatechinol, phenol, pyrogallol, oxyhydrochinone, picric, salicylic, vanillic, gallic and protocatechuic acids may be substituted for tannin. Electric charges (P. D. 15 volts +elec. for 30 m.,—elec. for 1.25 hrs. in 70 c.c. m. cane sugar+30 c.c. s.w. Cold (s.w. at 0°-5° C. for 1-6 hrs.).	Then 30 drops $n/10$ NH_4OH added. After 1 hr. to s.w. The most favorable medium is 70 c.c. in cane sugar+30 c.c. s.w. Larvæ obtained.	High.	Delage, Y.	<i>Arch. d. z. exp. e. gen.</i> , 4th, 7, 1907, p. 445. and <i>C. R. Ac. Sc. Paris</i> , Nov. 4, 1907.
<i>Strongylocentrotus lividus</i> .		To s.w. segmentations and a few larvæ.	Many.	"	<i>Arch. d. z. exp. et gen.</i> , 4th, 9, Notes et Revue, XXX., 1908.
<i>Arbacia punctulata</i> .		Irregular segmentation.	Small.	Greeley, A. W., at Woods Hole.	<i>Am. J. Physiol.</i> , VI., p. 296, 1902.
Sea urchins		Membranes formed.		also Morgan, T. H. Herbst, C.	<i>Arch. f. Entw.</i> , X., p. 489, 1900.
<i>Strongylocentrotus lividus</i> .	Fat solvents (toluol, benzol, xylol, creasote and oil of cloves). Silver and copper salts (metallic Ag and Cu in s.w. also AgCl). No results with Fe, Ni, Pb, Pt or Au.	" "		"	<i>Biol. Centralb.</i> , 13, p. 14, 1893.
<i>Sphærechinus</i> .	Acid (50 cc. s.w.+3 c.c. $n/10$ CH_3COOH for 4-6 min.). $CHCl_3$ sat. sea water.	To s.w. Plutei.		"	<i>Mittheil. aus d. z. Stat. zu Neap.</i> , 16, p. 445, 1904.
<i>Echinus microtuberculatus</i> .		Membranes formed.		"	<i>Arch. Entw.</i> , 22, p. 473, 1906.
<i>Echinus</i> .	Strychnin (0.1 per cent. strychnin sulphate for .5-3 hrs.).	To s.w. Division.		Hertwig, O. and R. Hertwig.	"Untersuchungen z. Morphologie u. Physiol. der Zena," H. 5. Jena, 1887. "Festschrift für gegenbauer," 2, p. 21, 1896.

¹ Loeb has shown that these solutions are all hyperosmotic (*C. R. Ac. Sc. Paris*, 146, p. 246, 1908). Isotonic sols. are not necessarily isosmotic (Loeb, *Biochem. Zeit.*, II, p. 144, 1908).

SEA-URCHINS.—Continued.

Egg of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
<i>Arbacia</i> .	Concentrated sea water (by evap.; 500 c.c. s.w. evap. to 250-375 c.c.; for 2 hrs.).	Segmentation and gastrulae.	90 40	Hunter, S. J., at Woods Hole.	<i>Am. J. Physiol.</i> , VI, p. 177, 1902.
<i>Strongylocentrotus purpuratus</i> and <i>franciscanus</i> .	Sperm extract (killed by 70-100° and filtered; of <i>Chiton</i> , <i>Asterias</i> , <i>Asterina</i> , <i>Strongylocentrotus</i> ; equal pts. conc. extract and s.w.).	To s.w. at 8°-10° C. or to hypertonic s.w. (8 c.c. 2.5 NaCl + 50 c.c. s.w.) for 35-50 min. To s.w. Plutei.	Few. 90	Kupelwieser, H.	<i>Biol. Centralb.</i> , 26, p. 744, 1906.
<i>Arbacia</i> , <i>Strongylocentrotus</i> .	Hypertonic sea water (50 c.c. 20/8 n MgCl ₂ + 5 c.c. s.w. for 2 hrs.), also with NaCl, sugar, urea (10 c.c. NaCl or KCl 2.5 n + 90 c.c. s.w. for 2 hrs.).			Loeb, J., at Woods Hole and Pacific Grove.	<i>Am. Journ. Physiol.</i> , III., p. 135, 1899; IV., p. 178, 1900; III., p. 434, 1900.
<i>Strongylocentrotus</i> , <i>purpuratus</i> and <i>franciscanus</i> .	Acids (monobasic fatty). 0.6 c.c. m. ethyl acetate ¹ to 50 c.c. s.w. 3 c.c. n/10 fatty acid to 50 c.c. s.w. for 2-3 m. 4 c.c. n/10 HNO ₃ to 50 for 2-5 min. Hypertonic s.w. (7-8 c.c. 2.5 n KCl + 50 c.c. s.w. for 1.5-2 hrs.).	Hypertonic s.w. (7-8 c.c. 2.5 n KCl + 50 c.c. s.w. for 25-50 m.) to s.w. Larvæ obtained. Hypertonic s.w. 25-50 min. to s.w. 3 c.c. n/10 CH ₃ COOH + 50 c.c. s.w. for 2-3 min. to s.w.	90-100 90-100 Few. 90-100	Loeb, J. " " "	<i>U. Calif. Pub. Physiol.</i> , II., p. 83, 1905. <i>Id.</i> , p. 113. <i>Id.</i> , p. 89.
<i>Strongylocentrotus</i> .	Fat solvents (sal. sols. of toluol, amylene, etc., in s.w.) phenol (6 c.c. m/2 phenol to 50 c.c. s.w.).	After membrane formation, hypertonic treatment to s.w. Larvæ.	Small.	"	<i>Id.</i> , III., p. 74, 1907.
"	Alkalies (50 c.c. 5/8 m Vant' Hoff's sol. + 0.5-1.0 c.c. n/10 NaOH for 2 hrs.). Hypertonic Vant' Hoff's sol. (50 c.c. sol. + 8 c.c. 2.5 NaCl for 2 hrs.).	Hypertonic s.w. for 30-50 m. to s.w. plutei. 50 c.c. 5/8 sol. or s.w. + 1.5 c.c. NaOH for 1.5-2 hrs.	Majority.	"	<i>Arch. f. d. ges. Physiol.</i> , 118, p. 30, 1907, and 118, p. 572, 1907.

¹ Free CH₃COOH present.

SEA-URCHIN.—Continued.

Egg of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
<i>Strongylocentrotus</i> .	Blood sera (of worms, <i>Dendrostoma</i> and <i>Sipunculus</i> diluted 1,000–5,000 times with s.w.).	To s.w. after membrane formation gives 10–32 cell stages. Hypertonic treatment gives plutei.	10–90	Loeb, J.	<i>Arch. f. d. ges. Physiol.</i> , 118, p. 36, 1907, and <i>U. Calif. Pub. Physiol.</i> , 3, p. 57, 1907.
"	Saponin, solanin, digitalin. (A trace in 5 c.c. s.w. for 5–8 m.) Bile salts (Na glycocholate and Na taurocholate). Heat (slow warming to 34°–35°). Blood serum (rabbit—6–7 c.c.+1 c.c. 2.5 NaCl or 4 c.c. s.w.+4 drops serum).	Hypertonic sea water for 35–80 min.; larvæ. Hypertonic sea water for 35–80 min.; larvæ. Membranes formed. After membranes formed and hypertonic treatment, larvæ produced.	10–80	"	<i>Arch. f. d. ges. Physiol.</i> , 122, p. 196, 1908.
"	Blood serum (pig and ox) treated as with rabbit serum.	Sr and Ba increase activity, Mg and Ca decrease activity of serum.	Most.	"	<i>Arch. f. d. ges. Physiol.</i> , 122, p. 196, 1908.
"	Soaps (only if trace free acid present). Membrane formation by any method.	Hypertonic solutions for 58 min. at 15° C. Saccharose 0.96 m., Glucose 1.04 m., NaCl 0.79 m., KCl 0.78 m., LiCl 0.74 m., CaCl ₂ 0.50 m., MgCl ₂ 0.47 m., SrCl ₂ 0.78 m., Urea 1.50 m.	80 90 90 80 85 80	" "	<i>Id.</i> , p. 45. <i>Biochem. Zeit.</i> , 11, p. 144, 1908.
Sea urchins of California coast.					

SEA-URCHINS.—Continued.

Egg of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Sea-urchins of California coast.	Membrane formation by any method.	Hypertonic sea water for 25-50 min.		Loeb, J.	<i>Id.</i>
Sea-urchins of California coast	" " "	50 c.c. s.w.+8 c.c. 2.5 KCl, 50 c.c. s.w.+6.5 c.c. 2.5 LiCl, 50 c.c. s.w.+5 c.c. 2.5 CaCl ₂ , 50 c.c. s.w.+4.5 c.c. 2.5 MgCl ₂ , 50 c.c. s.w.+12 c.c. s.w. MgSO ₄ , 50 c.c. s.w.+14.4 c.c. 2.5 glucose, 50 c.c. s.w.+10 c.c. 2.5 saccharose.		"	
Sea-urchins of California coast.	" " "	Sea water at 2-5° C.		"	Article on parthenogenesis in Oppenheimer's
Sea-urchins of California coast.	" " "	Oxygen-free s.w. by current of hydrogen.		"	"Handbuch der Biochemie des Menschen u. der Tiere, B. II, 1st half, p. 97. Jena, 1909. Also <i>Biochem. Zeit.</i> , I., p. 202, 1906.
Sea-urchins of California coast.	" " "	KCN sea water (1.5-1 c.c. 0.1 per cent. KCN+50 c.c. s.w. for 5-8 hrs.).		"	
Sea-urchins of California coast.	" " "	Chloral hydrate s.w. (3 c.c. n/10 chloral hydrate +50 c.c. s.w. for 3-6 hrs.).		"	

SEA-URCHINS.—Continued.

Key of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
<i>Arbacia pustulata</i> and <i>Strongylocentrotus lividus</i> .	Acids (2-7 c.c. $n/10$ HCl+100 c.c. s.w. for 5-15 min.) (dilute (1/2-1/6 sat.) CO_2 sea water 2-20 min.) Hypertonic sea water (10-16 c.c. 2.5 n KCl or NaCl+100 c.c. s.w. for 1-2 hrs.). KCN $m/100-m/1,000$ for 1-2 days. O-free sea water (by H gas; 30 min. or longer).	To s.w. Plutei. To s.w. segmentations and a few larvæ. To s.w. Plutei. To s.w. No larvæ but segmentations. To s.w. Divisions.	10 High. High.	Lyon, E. P., at Naples. Lyon, E. P., at Naples. Lyon, E. P., at Naples. Mathews, A. P., at Woods Hole.	<i>Am. Journ. Physiol.</i> , IX., p. 308, 1903. <i>Am. Journ. Physiol.</i> , IX., p. 308, 1903. <i>Am. Journ. Physiol.</i> , IX., p. 308, 1903. <i>Am. J. Physiol.</i> , IV, p. 343, 1900.
"	Alcohol (10 c.c. s.w.+1 c.c. 50 per cent. $\text{C}_2\text{H}_5\text{OH}$ for 10-15 min.). Also saturated ether and CHCl_3 sea water.	To s.w. Divisions.			
"	Pilocarpine, strychnine and quinine. Distilled water (1 min.).	To s.w. Divisions. To s.w. Larvæ.		Schücking, A. "	<i>Arch. f. d. ges. Physiol.</i> , 97, p. 85, 1903. <i>Id.</i>
<i>Arbacia pustulata</i> .	Cold (3-4° C. for 3 hrs.). NaHCO_3 (1.5 per cent. for 10 min.). Nicotin, hyocyanin, strychnine (1 drop nicotin to 100 c.c. s.w.); 1 part 0.25 per cent. hyocyanin+3 parts s.w.	To s.w. Blastulæ. To s.w. Gastrulæ. After 2 hrs. to s.w. Irregular segmentation.		" Wassilief, A., at Villefranche.	<i>Id.</i> <i>Biol. Centralb.</i> , 22, p. 738, 1902.
<i>Strongylocentrotus lividus</i> .	Hypertonic sea water (1 part s.w.+1 part 20/8 m MgCl_2 for 1-2 hrs.).	To s.w. Plutei.		Wilson, E. B. at Beaumont.	<i>Arch. Entom.</i> , XII., p. 529, 1901.

VERTEBRATES.

Key of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
<i>Leuciscus vutlis.</i>	Hypertonic solutions (10 per cent. cane sugar 3 hrs., 1 per cent. NaCl, 3 hrs.)	To water. Irreg. segmentations but furrows later disappear; development questionable.	50	Bataillon, E.	<i>Arch. Entom.</i> , XI., p. 169, 1900, and <i>C. R. Ac. Sc. Paris</i> , 134, p. 918, 1902.
<i>Rana esculenta.</i>	Ox serum. 1-2.5 hrs.	To water. Segmentation	90	"	<i>Arch. Entom.</i> , 18, p. 17, 1904, and <i>C. R. Ac. Sc. Paris</i> , 137, p. 79, 1903.
<i>Rana fusca.</i>	Heat (water at 35° for 30 min.).	To water. Segmentation		"	
"	Hypertonic sols. (6 per cent. cane sugar, 8-15 hrs.).	To water. Segmentation		"	
"	Heat + 6-8 per cent. cane sugar.	Blastulae.		"	
<i>Petromyzon planeri.</i>	Hypertonic sols. 6 per cent. cane sugar.	Segmentation.		"	<i>Id.</i>
Fish.	Diphtheria antitoxin.	Segmentation?		Kulagin.	<i>Zool. Anz.</i> , 1898, p. 653.